Body Mass Index, Physical Activity, and the Risk of Decline in Overall Health and Physical Functioning in Late Middle Age

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Objectives. We examined the relation between body mass index, exercise, overall health, and physical functioning.

Methods. We studied 7867 adults aged 51 to 61 years in 1992 to 1996. Adjusted relative risks for health decline and new physical difficulties were determined with logistic regression.

Results. Overweight and obesity were independently associated with health decline (adjusted relative risk [ARR] = 1.29 and 1.36) and development of a new physical difficulty (ARR = 1.27 and 1.45). Regular exercise significantly reduced the risk of health decline and development of a new physical difficulty, even among obese individuals.

Conclusions. Maintaining ideal body weight is important in preventing decline in overall health and physical functioning. However, regular exercise can reduce the risk of health decline even among individuals who cannot achieve ideal weight. (*Am J Public Health.* 2004;94:1567–1573)

Previous studies have linked obesity with cardiovascular outcomes,[1] life expectancy,[2] mortality,[3,4] and the risk of cancer.[5–7] Population studies and short-term trials have shown that physical activity is associated with reductions in coronary heart disease risk[8,9] and improvement in cardiorespiratory fitness and physical performance.[10,11]

However, there have been few large longitudinal studies investigating the relationship between body mass index (BMI), physical activity, and the risk of decline in overall health and physical functioning.[12,13] Vita and colleagues showed that smoking, BMI, and physical activity patterns in midlife and late adulthood predicted development of disability among a group of university alumni.[12] However, these 3 risk factors were combined into a single risk index in multivariate analyses, so the independent effects of each are unclear. Moreover, it is not known whether regular exercise can ameliorate the adverse effects of obesity on health. Using data from the Health and Retirement Study (HRS), we examined the relation between BMI, physical activity, and the risk of a decline in self-reported overall health and physical functioning over 4 years among a national sample of US adults aged 51 to 61 years in 1992.

METHODS

Study Population

Analyses were conducted with the use of publicly available data files from the HRS.[14] The HRS is a longitudinal study sponsored by the National Institute on Aging and conducted by the Institute for Social Research at the University of Michigan. The HRS targeted community-dwelling adults in the contiguous United States who were 51 to 61 years old in 1992. Blacks, Hispanics, and Florida residents were oversampled. The HRS conducted in-home interviews in 7702 households (82.0% response rate), yielding 9824 participants aged 51 to 61 years for the initial interview. Follow-up telephone interviews were conducted every 2 years. Vital status was determined through the National Death Index and household contacts.

Independent Variables

BMI. The HRS collected self-reported data as weight in pounds and height in feet and inches at baseline and the follow-up waves. We converted weight into kilograms and height into meters for each wave. BMI was calculated as weight in kilograms divided by the square of the height in meters. The BMI was then categorized according to the recommendations of the World Health Organization[15]: below-normal weight (<18.5 kg/m^2), normal range (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), obesity (30.0–39.9 kg/m^2), and extreme obesity (40 kg/m^2 or higher). In our analysis, we used average BMI in the years 1992 to 1994 to predict risk of decline in overall health and development of new mobility difficulty in 1992 to 1996. A total of 95 participants had below-normal weight. There are a variety of causes for having below-normal weight (e.g., HIV) that were not measured by the HRS. Because of the small number of individuals in this category and the likelihood of unmeasured confounding, this group was excluded from analysis.

Physical activity. In the baseline interview (1992), leisure-time physical activity was assessed by 2 questions: (1) "How often do you participate in light physical activity, such as walking, dancing, gardening, golfing, or bowling, etc.?" and (2) "How often do you participate in vigorous exercise or sports, such as aerobics, running, swimming, or bicycling?" In addition, the HRS investigators asked: "How often do you do heavy housework like scrubbing floors or washing windows?" In 1994, 2 questions were asked: "How often do you participate in light physical activity, such as walking, dancing, gardening, golfing, bowling, etc.?" and "How often do you participate in vigorous physical exercise or sports—such as heavy house work, aerobics, running, swimming, or bicycling?"

The HRS changed the response options to the questions about leisure-time physical activity from 1992 to 1994. In 1992, the options were "3 or more times a week," "1 or 2 times a week," "1 to 3 times a month," "less than once a month," or "never." In 1994, participants were asked to specify how often they exercised using whatever time frame they wanted (i.e., times per week, month, year, or day). Ten participants who responded "don't know" or who refused to answer were as-

signed to the "none/never" category. For our analysis, we used average physical activity in 1992 to 1994 to predict changes in health from 1992 to 1996. To calculate the average frequency of light and vigorous exercise using the different response options described above, we first converted frequency of exercise for both waves to times per year. Second, average levels of exercise were determined by the sum of physical activity in 1992 and 1994, and this was then converted into times per week. Finally, the frequency of exercise was categorized as "never," "<0.25 times per week or less than once a month," "0.25–0.74 times per week or 1–3 times a month," "0.75–2 times per week or 1–2 times a week," and "3 or more times a week."

Self-reported work-related physical activity was assessed on the basis of a participant's response to the question, "Does your job require lots of physical effort, such as lifting heavy loads, stooping, kneeling, or crouching?" The response options were that this was true "all or almost all of the time," "most of the time," "some of the time," or "none or almost none of the time." In the 1994 HRS interview, work-related physical activity was assumed to be the same as in 1992 for those who reported there had been no changes in their job. Those who changed job were asked about work-related physical activity; for these cases, we took the average of the 1992 and 1994 values.

Other covariates. Age, sex, socioeconomic status, health behaviors, baseline mobility difficulty, and insurance status were included a priori as covariates in all models because of their significance in a previous study.[16] Race was categorized as White, African American, Mexican American, other Hispanic, and other races. Educational levels were grouped as 0 to 8 years, 9 to 11 years, high school graduates (12 years), and some college or higher (>12 years). Household income was classified as less than 100%, 100% to 199%, 200% to 299%, 300% to 499%, and 500% or more of the federal poverty level.[17] Smoking status was determined as never, past smoker, and current smoker. Alcohol consumption was divided into light to moderate drinking (up to 2 drinks per day) and heavy drinking (more than 2 drinks/day), relative to abstainers. The number of mobility difficulties at baseline ranged from 0 to 4, with higher scores indicating more difficulty in walking and climbing stairs. Insurance status was classified as continuously insured, intermittently uninsured, and continuously uninsured.

Health Outcomes: Self-Reported Overall Health

Self-reported overall health was assessed by the following question: "Would you say your health is excellent, very good, good, fair, or poor?" On the basis of participants' responses to this question in 1992 and 1996, we created a dichotomous outcome variable "major decline in self-reported health between 1992 and 1996," defined as the presence or absence of either a decline from excellent, very good, or good health in 1992 to fair or poor health in 1996 or a decline from fair health in 1992 to poor health in 1996.[16]

Physical Difficulties

Four mobility questions were used to assess self-reported physical difficulties. These questions, which were previously described by the HRS investigator,[18] examined how difficult it was for the participant to walk several blocks, walk 1 block, climb 1 flight of stairs without resting, and climb several flights of stairs without resting. The HRS used different options for the responses to the questions about physical functioning from 1992 to 1996. In 1992, the options were "not at all difficult," "a little difficult," "somewhat difficult," and "very difficult or can't do." In 1994 and 1996, respondents were asked to choose among "no," "yes," and "doesn't do or can't do."

Because of these differences, questions for all years were collapsed into dichotomous variables indicating no difficulty or some degree of difficulty.[19] A new mobility difficulty between 1992 and 1996 was defined as the development of any new physical difficulty (i.e., a transition from "not at all difficult" in 1992 to reporting "yes" or "can't do" in 1996). Persons who said they had no difficulty with an activity in 1992 and then said they "did not do" an activity in 1996 were categorized as having developed a new physical difficulty; those who responded "did not do" had similar self-reported health to those who reported having difficulty.[16] Finally, outcome variables were created that indicated the development of 1 or more new physical difficulties from 1992 to 1996.

Statistical Analysis

Analyses were conducted with Stata statistical software (Stata Corp, College Station, Tex). Study cohort was tracked by numbers of participants who completed interviews or were lost to follow-up. Analysis of variance was used to examine whether there were differences in baseline characteristics among completers or noncompleters. Participant characteristics were assessed according to BMI category. Significance tests were performed with an adjusted Wald test for continuous variables and the Pearson χ^2 statistic for categorical variables.

To assess the potential relationship between study variables, we performed both simple and multivariate logistic regression analyses. First, bivariate analyses were conducted to examine the associations of BMI and exercise frequency with the risk of a decline in overall health and physical functioning. Second, multivariate analyses were conducted to determine independent predictors of (1) a major decline in overall health and (2) development of a new mobility difficulty from 1992 to 1996, with adjustment for all aforementioned variables. To determine whether the effects of exercise varied according to BMI, we repeated the logistic regressions with stratification for individuals who were normal, overweight, and obese. The number of persons with below-normal weight or extreme obesity was too small for separate stratified analyses, so we excluded below-normal weight participants and combined the extremely obese with obese persons in the stratified analyses. Because a major decline in health or a new mobility difficulty could not occur in participants who reported being in the worst baseline health, the relevant analyses excluded the 360 participants (4.8%) who were in poor health at baseline and the 453 participants (6.0%) who had difficulties with 4 of the activities related to mobility.

Odds ratios were converted to relative risks by means of published formulas.[20] All analyses accounted for the complex survey design and for person-level analytic weights. To account for differential loss to follow-up, all models were repeated, including a covariate indicating the probability of loss to follow-up.[21] The results were very similar, and only the results of the baseline models are presented.

RESULTS

Study Population

Of the 9824 participants who were interviewed in 1992, a total of 1138 (11.6%) were lost to follow-up and 377 (3.8%) were dead in 1996. We restricted our study to participants who had complete data on BMI, physical activity, self-reported overall health, and physical functioning in 1992 to 1996. Thus, 442 participants (4.5%) were excluded because of missing data. A total of 7867 participants (80.1%) were included in our analyses. Participants who were lost to follow-up (including dropping out, death, and incomplete data) were significantly more likely to be male and non-White; they had lower income, less education, and worse overall health and physical functioning, and they reported less physical activity.

Participant characteristics, stratified by BMI category at baseline, are shown in Table 1. Overweight and obese participants were more likely than those with normal weight to be African American or Hispanic and were less educated. They also had more chronic diseases or physical difficulties and were more likely to report being in poor health. Overweight and obese participants were also more likely to be sedentary or to have low levels of either light physical activity or vigorous exercise or household chores, or of both. Interestingly, overweight and obese participants reported smaller differences on job-related physical effort compared with normal-weight participants.

Body Weight and Health Outcomes

The risk of a decline in self-reported overall health and development of a new physical difficulty steadily increased across the categories of normal, overweight, obesity, and extreme obesity (Table 2). Obese and overweight participants were more likely than normal-weight persons to have a major decline in self-reported overall health (12.4%, 10.4%, and 7.5%, respectively; $P<.001$ for both comparisons). After adjustment for other baseline characteristics, being obese and being overweight were independently associated with a higher risk of health decline, with adjusted relative risks of 1.36 (95% confidence interval [CI]=1.06, 1.72) and 1.29 (95% CI=1.02, 1.62). Obese and overweight participants were also more likely to develop a new mobility difficulty, with adjusted relative risks of 1.75 (95% CI=1.55, 1.96) and 1.27 (95% CI=1.11, 1.45). The extremely obese participants had the greatest risk of developing a new mobility difficulty (adjusted relative risk=2.43, 95% CI=1.94, 2.96).

Physical Activity and Decline in Overall Health or Physical Functioning

Table 3 presents the risk of a decline in overall health or physical functioning according to a participant's self-reported frequency and intensity of physical activity. All levels of non–job-related physical activity were associated with a lower risk of decline in overall health compared with being sedentary. The rates of decline in overall health decreased from 20.8% among those who said they never did light exercise to 8.4% among those who did light exercise an average of 3 or more times per week. After adjustment for other covariates (including vigorous exercise or household chores and work-related activity), the adjusted relative risk of a decline in overall health was over 30% lower for individuals who performed light exercise 1 to 3 times per month, 1 to 2 times per week, or 3 or more times per week. The benefits of light exercise were similar across these 3 categories.

The results were similar for vigorous exercise or household chores. The rates of decline in overall health decreased from 15.0% among those who said they never did vigorous exercise to 6.7% among those who did vigorous exercise an average of 3 or more times per week. After adjustment for other covariates (including light exercise and work-related activity), the adjusted relative risk of a decline in overall health was approximately 25% lower for individuals who ever performed vigorous exercise. Surprisingly, the benefits of vigorous exercise were similar regardless of the frequency, with similar adjusted relative risks for individuals who performed vigorous exercise less than once per month and those who performed vigorous activities 3 or more times per week. However, job-related physical effort was not associated with lower rates of decline in overall health in either bivariate or multivariate analyses (Table 3).

In terms of the risk of developing a new physical difficulty, all levels of non–job-related physical activity were associated with a lower risk of decline in physical functioning compared with being sedentary, although some of the findings for light exercise were of borderline statistical significance. The rates of developing a new physical difficulty decreased from 22.8% among those who said they never did light exercise to 16.9% among those who did light exercise an average of 3 or more times per week. After adjustment for other covariates (including vigorous exercise or household chores and work-related activity), the adjusted relative risk of developing a new physical difficulty was 22% to 31% lower for individuals who performed light exercise more than once per month.

The results were much more pronounced for vigorous exercise or household chores. The rates of decline in physical functioning decreased from 22.2% among those who said they never did vigorous exercise to 12.2% among those who did vigorous exercise an average of 3 or more times per week. After adjustment for other covariates (including light exercise and work-related activity), the adjusted relative risk of developing a new physical difficulty steadily declined as the frequency of vigorous exercise or household chores increased, ranging from 0.83 (95% CI=0.69, 0.97) for those who performed vigorous activities less than once per month down to 0.57 (95% CI=0.43, 0.76) for those who performed vigorous activities 3 or more times per week. Again, job-related physical effort was not associated with lower rates of decline in overall health in either bivariate or multivariate analyses (Table 3).

Benefits of Physical Activity Across Body Mass Index Strata

Regular light or vigorous exercise was associated with lower risk of developing a new mobility difficulty regardless of whether individuals were normal weight, overweight, or obese (Table 4). For example, the adjusted relative risks of developing a new mobility difficulty were 0.45 (95% CI=0.26, 0.76) for obese individuals who performed vigorous exercise 1 to 2 times per week and 0.46

TABLE 1—Baseline (1992) Characteristics of 7867 Participants in Study of Relationship Between Body Mass Index, Exercise, Overall Health, and Physical Functioning

Characteristic	Body Mass Index				
	Normal (n = 2640)	Overweight (n = 3234)	Obesity (n = 1716)	Extreme Obesity (n = 182)	P[a]
Mean age, y (SE)	55.9 (0.07)	56.1 (0.06)	55.8 (0.09)	55.6 (0.26)	.300
Female, %	62.0	43.8	53.7	78.8	<.001
Mean education, y (SE)	12.9 (0.10)	12.4 (0.10)	12.0 (0.11)	11.7 (0.22)	.007
White, %	87.9	83.7	78.2	72.3	<.001
Mean no. of difficulties with mobility (SE)[b]	0.71 (0.03)	0.88 (0.03)	1.35 (0.03)	2.40 (0.11)	<.001
Mean no. of chronic diseases (SE)[c]	0.89 (0.02)	1.14 (0.02)	1.50 (0.03)	2.14 (0.10)	<.001
Self-reported health status, %					<.001
Poor	4.8	5.4	8.9	19.7	
Fair	9.5	11.1	17.6	24.7	
Good	21.3	27.1	32.1	31.5	
Very good	32.0	32.2	27.7	17.1	
Excellent	32.5	24.2	13.8	6.9	
Physical activity, %[d]					
Light exercise					<.001
Never	6.9	7.2	12.0	18.3	
<1 time/mo	6.6	6.6	8.4	15.9	
1–3 times/mo	7.9	9.2	9.5	13.5	
1–2 times/wk	19.8	22.8	24.6	17.5	
≥3 times/wk	58.8	54.2	45.6	34.7	
Vigorous exercise					<.001
Never	41.5	44.3	56.5	75.7	
<1 time/mo	19.9	21.9	20.7	12.2	
1–3 times/mo	9.2	9.4	7.2	3.4	
1–2 times/wk	12.1	11.4	6.6	3.6	
≥3 times/wk	17.3	13.0	9.0	5.0	
Heavy housework					<.001
Never	19.1	27.0	27.7	28.7	
<1 time/mo	25.4	27.0	26.7	28.8	
1–3 times/mo	23.6	20.8	20.6	17.8	
1–2 times/wk	23.5	18.7	19.0	19.3	
≥3 times/wk	8.5	6.5	6.1	5.4	
Job requires physical effort					<.001
None or almost none of the time	56.0	49.1	51.9	68.0	
Some of the time	13.1	15.4	15.1	11.4	
Most of the time	11.6	13.7	13.4	7.1	
All or almost all of the time	19.4	21.8	19.6	13.5	

Note. Data were adjusted for the complex design of the survey and analytic weights. Because of rounding, percentages may not total 100. There were statistically significant differences across body mass index subgroups on marital status, income, smoking, and drinking behaviors (data not shown).
[a] Significance tests for continuous variables were performed with an adjusted Wald test (approximate F statistic). Significance tests for categorical variables were performed with the Pearson χ^2 statistic.
[b] The mobility scale ranges from 0 to 4, with higher scores indicating more difficulty walking and climbing stairs.
[c] The chronic diseases included hypertension, diabetes, heart disease, chronic lung disease, cancer, arthritis, stroke, and difficulties with vision.
[d] Light exercise is walking, dancing, gardening, golfing, bowling, etc. Vigorous exercise or sports are aerobics, running, swimming, or bicycling. Household chores include scrubbing floors or washing windows. Work-related physical activity was determined on the basis of participants' response to the question, "Does your job require lots of physical effort, such as lifting heavy loads, stooping, kneeling, or crouching?"

(95% CI=0.22, 0.91) for those who exercised more than 3 times per week compared with being sedentary. The trends were similar for analyses of the risk of a major decline in overall health (data not shown), although the beneficial effects of regular physical activity on overall health were somewhat weaker than those shown in Table 4.

DISCUSSION

As expected, being obese was associated with a much greater risk of decline in overall

TABLE 2—Risk of Major Decline in Self-Reported Overall Health and Development of a New Mobility Difficulty, by Average Body Mass Index

Variable	Average Body Mass Index			
	Normal	Overweight	Obesity	Extreme Obesity
No. of participants eligible for analysis	2625	3213	1704	235
Decline in overall health				
Major decline, n (%)	222 (7.5)	363 (10.4)***	228 (12.4)***	34 (14.2)***
Relative risk of decline (95% CI)				
Crude	Reference	1.39 (1.15, 1.67)**	1.64 (1.37, 1.97)**	1.89 (1.37, 2.57)**
Adjusted[a]	Reference	1.29 (1.02, 1.62)*	1.36 (1.06, 1.72)*	1.45 (0.98, 2.10)
New mobility difficulty				
Mobility difficulty, n (%)	397 (14.7)	575 (17.3)***	418 (23.5)***	68 (28.4)***
Relative risk of mobility difficulty (95% CI)				
Crude	Reference	1.18 (1.03, 1.35)*	1.60 (1.42, 1.80)**	1.93 (1.53, 2.40)**
Adjusted[a]	Reference	1.27 (1.11, 1.45)**	1.75 (1.55, 1.96)**	2.43 (1.94, 2.96)**

Note. CI = confidence interval. Data were adjusted for the complex design of the survey and for the person-level analytic weights. *P* values are for the comparison with normal-weight participants (the reference category).
[a]Relative risks have been adjusted for age, sex, race or ethnic group, income, educational level, marital status, smoking and drinking behaviors, self-reported overall health, mobility scale, insurance status, and frequency of light exercise, vigorous exercise or household chores, and work-related physical activity.
*$P < .05$; **$P < .01$; ***$P < .001$.

TABLE 3—Risk of Major Decline in Overall Health or Developing a New Mobility Difficulty According to Frequency of Physical Activity

Frequency of Physical Activity	Major Decline in Overall Health			New Mobility Difficulty		
	n (%)	Crude RR (95% CI)	Adjusted RR (95% CI)	n (%)	Crude RR (95% CI)	Adjusted RR (95% CI)[a]
Light exercise						
Never (n = 357)	78 (20.8)	Reference	Reference	80 (22.8)	Reference	Reference
< 1 time/mo (n = 675)	96 (14.2)***	0.68 (0.48, 0.94)*	0.86 (0.60, 1.18)	158 (21.9)**	0.96 (0.73, 1.24)	0.89 (0.65, 1.16)
1–3 times/mo (n = 2122)	260 (10.9)***	0.52 (0.39, 0.70)**	0.68 (0.49, 0.93)*	430 (19.4)**	0.85 (0.65, 1.10)	0.78 (0.56, 1.03)
1–2 times/wk (n = 1485)	141 (8.2)***	0.39 (0.30, 0.52)**	0.63 (0.47, 0.83) **	255 (16.2)**	0.71 (0.54, 0.92)*	0.69 (0.49, 0.92)*
≥3 times/wk (n = 3228)	287 (8.4)***	0.40 (0.29, 0.55)**	0.69 (0.51, 0.93)*	559 (16.9)**	0.74 (0.55, 0.98)*	0.75 (0.53, 1.01)
Vigorous exercise or household chores						
Never (n = 957)	154 (15.0)	Reference	Reference	212 (22.2)	Reference	Reference
< 1 time/mo (n = 2855)	349 (11.2)***	0.75 (0.61, 0.91)**	0.79 (0.63, 0.98)*	608 (20.3)***	0.91 (0.77, 1.07)	0.83 (0.69, 0.97)*
1–3 times/mo (n = 2653)	252 (8.6)***	0.58 (0.47, 0.71)**	0.75 (0.60, 0.93)*	471 (17.3)***	0.78 (0.64, 0.94)**	0.73 (0.59, 0.89)**
1–2 times/wk (n = 705)	56 (7.1)***	0.47 (0.34, 0.65)**	0.69 (0.49, 0.96)*	100 (12.9)***	0.58 (0.47, 0.71)**	0.58 (0.48, 0.70)**
≥3 times/wk (n = 697)	51 (6.7)***	0.45 (0.32, 0.62)**	0.76 (0.54, 1.05)	91 (12.2)***	0.55 (0.42, 0.71)**	0.57 (0.43, 0.76)**
Job requires physical effort						
None or almost none of the time (n = 3718)	392 (9.3)	Reference	Reference	705 (18.0)	Reference	Reference
Some of the time (n = 1729)	165 (8.8)*	0.94 (0.76, 1.16)	1.07 (0.85, 1.34)	288 (16.6)*	0.92 (0.81, 1.05)	0.96 (0.84, 1.09)
Most of the time (n = 1247)	149 (11.7)*	1.26 (1.03, 1.52)*	1.13 (0.92, 1.39)	231 (17.2)*	0.96 (0.82, 1.11)	0.91 (0.76, 1.07)
All or almost all of the time (n = 1173)	156 (12.3)*	1.32 (1.05, 1.65)*	1.09 (0.82, 1.43)	258 (21.7)*	1.21 (1.05, 1.34)**	1.06 (0.91, 1.22)

Note. RR = relative risk; CI = confidence interval. Data were adjusted for the complex design of the survey and for the person-level analytic weights. *P* values are for the comparison with sedentary participants (the reference category).
[a]Relative risks have been adjusted for baseline age, sex, race or ethnic group, income, educational level, marital status, smoking and drinking behaviors, self-reported overall health, mobility scale, insurance status, and body mass index.
*$P < .05$; **$P < .01$; ***$P < .001$.

health and physical functioning compared with having normal weight. However, overweight participants also were at increased risk (adjusted relative risk = 1.29 for major decline in overall health and 1.28 for development of a new mobility difficulty). It is likely that some individuals in the overweight group underreported their weight and were actually obese at baseline. In addition, some may have gained weight over time, leading to worse health and physical functioning. Nevertheless, our findings suggest that even a mild degree

TABLE 4—Adjusted Relative Risk of Developing a New Mobility Difficulty According to Frequency of Physical Activity, Stratified by Average Body Mass Index

	Relative Risk for Frequency of Light Exercise (95% CI)				
Average Body Mass Index	Never[a]	<1 time/mo	1–3 times/mo	1–2 times/wk	≥3 times/wk
Normal (n = 2475)		0.66 (0.27, 1.39)	0.79 (0.35, 1.55)	0.73 (0.32, 1.46)	0.74 (0.32, 1.47)
Overweight (n = 2976)		1.02 (0.60, 1.59)	0.72 (0.44, 1.13)	0.61 (0.36, 0.98)*	0.68 (0.39, 1.11)
Obesity (n = 1680)		0.78 (0.45, 1.25)	0.63 (0.40, 0.96)	0.55 (0.37, 0.80)**	0.68 (0.45, 1.01)
	Relative Risk for Frequency of Vigorous Exercise or Household Chores (95% CI)				
	Never[a]	<1 time/mo	1–3 times/mo	1–2 times/wk	≥3 times/wk
Normal (n = 2475)		0.81 (0.57, 1.11)	0.70 (0.48, 1.00)*	0.56 (0.35, 0.87)**	0.42 (0.25, 0.68)**
Overweight (n = 2976)		0.95 (0.69, 1.26)	0.83 (0.58, 1.16)	0.66 (0.46, 0.91)**	0.78 (0.51, 1.14)
Obesity (n = 1680)		0.68 (0.48, 0.96)*	0.63 (0.41, 0.95)*	0.45 (0.26, 0.76)**	0.46 (0.22, 0.91)*

Note. The results presented are relative risks and 95% confidence intervals (CIs). Data were adjusted for the complex design of the survey and analytic weights. Participants with extreme obesity were deleted because the number was too small to conduct separate stratified analyses. *P* values are for the comparison with sedentary participants (the reference category). Relative risks have been adjusted for age, sex, race or ethnic group, income, educational level, marital status, smoking and drinking behaviors, self-reported overall health, mobility scale, and insurance status.
*$P < .05$; **$P < .01$.
[a]Reference group.

of overweight can negatively affect health outcomes. Previous studies have shown a continuous relationship between BMI and risk of cardiovascular disease.[1,22,23]

Our findings regarding the relationship between exercise and overall health and physical functioning give cause for optimism. Even light exercise was associated with lower risks of a major decline in self-reported overall health and development of new mobility difficulties. Furthermore, benefits of physical activity were seen regardless of baseline weight. These findings from a nationally representative longitudinal study are consistent with short-term trials that demonstrated the beneficial effects of regular exercise on physical fitness.[10,11] Even if exercise does not lead to major reductions in weight, it may help ameliorate the consequences of obesity and overweight.

Job-related physical activities were not protective against the risk of health decline and development of a new mobility difficulty. There are several possible reasons for this. Most of the participants who reported that their job required "lots of physical effort" said that it frequently required "lifting of heavy loads," frequent "stooping, kneeling, or crouching," or both (data not shown). Thus, work-related physical activities may be less aerobic than leisure-time activities. In addition, some of the work-related physical activities may actually be harmful by causing back or other musculoskeletal injuries.[24,25] This may counteract any benefits from work-related aerobic activities. In addition, the work-related questions used the respondent's subjective assessment of physical effort; thus, individuals with poor physical conditioning may have been more likely to report that their job was strenuous. Finally, respondents may have overestimated their work-related activities.

Our findings raise questions about the health benefits of occupational activity. A cross-sectional study (National Health and Nutrition Examination Survey III) reported that the likelihood of being obese could be reduced by as much as one half with a physically active occupation,[26] but the actual intensity level of an occupation was not measured. Another report, from the 1993 Spanish National Health Survey of the Spanish population aged 20 to 60 years, suggested that neither BMI nor percentage of obesity varied significantly by work-related activity.[27]

A major limitation of this study is the reliance on self-reported weight, height, and physical activity. Previous studies suggested that participants tend to underestimate their weight and overestimate their height and physical activity.[28–31] Nondifferential misclassification of an exposure reduces the measured association between the exposure and the outcome.[32] Random inaccuracies in self-reported BMI, physical activities, or both would therefore lead us to underestimate the relationships between these variables and self-reported health and physical functioning. Additional studies are needed with more accurate measures of the frequency and intensity of physical activity. In addition, only 80% of the eligible population participated in the HRS, and 18% of those who participated were lost to follow-up, died, or had missing data. Adjusting for the probability of loss to follow-up did not substantially change our results. Nevertheless, selection bias through nonparticipation and differential loss to follow-up could introduce some bias into our estimates of the relationship between BMI, physical activity, and health outcomes.

In conclusion, our findings suggest that physician counseling and public health messages regarding weight control should also target the large population subgroup that is overweight as well as those who are obese. Although the efficacy of physician counseling about lifestyle modification is unclear, several studies have shown a positive impact.[33,34] Emphasizing that maintaining normal weight and exercising regularly can improve subjective health and physical functioning may motivate some patients who are relatively insensitive to messages about reducing their risk of cardiovascular disease and death. Finally, more studies are needed to understand the benefits and harms of work-related physical

activities. Work-related physical activity varied greatly according to race/ethnicity and socioeconomic status, and work-related physical activity is inversely correlated with leisure-time physical activity (data not shown). Thus, differences in work and leisure-time physical activity may contribute to disparities in health and physical functioning. ■

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Contributors

Both authors were involved in the conception and design of the study. X.Z. He contributed to literature review, statistical analyses, interpreting findings, and writing drafts, including the final draft. D.W. Baker supervised data analysis, refined the intellectual content, contributed extensively to all drafts, and provided editorial expertise.

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The institutional review board of Northwestern University granted approval for this study.

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